STATISTICAL DATA ON THE MECHANICAL CLEANING OF BITUMINOUS COAL IN THE UNITED STATES

BY R. L. ANDERSON

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by

R. L. Anderson 1/

Mechanical cleaning of bituminous coal in the United States was begun about 1875, with plants in western Pennsylvania and Illinois. The United States Geological Survey began to record the quantity of washed bituminous coal in 1906; and the series was carried forward to 1923, except that no data were collected for 1922. This statistical work was transferred to the Bureau of Mines in 1925, and the collection of data on mechanical cleaning was resumed in 1927. Data collected before 1927 include only the coal that was washed at the mines and do not include that cleaned by pneumatic methods at the mines and that cleaned at central washeries operated by consumers.2/ The total bituminous coal washed in 1906 was less than 10 million net tons. In 1927, the first year for which complete figures are available for all types of mechanical cleaning, 28 million net tons of bituminous coal were cleaned in the United States.

Acknowledgments

These statistics were compiled from detailed annual reports of production and mine operation furnished by bituminous coal producers. Assistance was also given by the manufacturers of coal-cleaning equipment, who reported data on annual sales of new equipment.

Definitions

This review covers the progress of mechanical cleaning of bituminous coal only and does not include the anthracites of eastern Pennsylvania. When the term bituminous coal is used, it means all coals in the United States and Alaska except Pennsylvania anthracite. There are no mechanical cleaning plants at lignite mines. The broad term "preparation" may mean any one or any combination of the following methods: (1) screening into sizes, (2) cleaning by hand picking or mechanical cleaning, (3) mixing or blending, and (4) dustless treatment. Since mechanical preparation includes screening as well as cleaning, the term mechanical cleaning refers only to cleaning with mechanical devices that effect separation of impurities from the raw coal by reason of differences in specific gravity. These mechanical devices are separated into the following classes; (1) jigs, (2) wet-process concentrating tables, (3) classifiers, (4) launders, (5) dense-medium, and (6) pneumatic methods. Where the words "clean," "cleaned," or "cleaning" are used without qualification,

1/ Engineer-economist, Bureau of Mines, United States Department of the Interior, Washington, D. C.

2/ Plein, L. N., Statistical Analysis of the Progress in Mechanical Cleaning of Bituminous Coal from 1927 to 1934, Bureau of Mines, 1936, p. 3.

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the implied meaning refers to results obtained by mechanical cleaning devices. Unless otherwise specified, tonnages given represent merchantable or usable coal after removal of impurities rather than the raw coal before treatment. All tonnage figures are net tons of 2,000 pounds.

Growth of Mechanical Cleaning 1927-49

The quantity of bituminous coal mechanically cleaned in the United States increased from 28 million tons, or 5 percent of the total production, in 1927 to 154 million tons, or 35 percent of the total production in 1949. (See table 1)

Refuse handled at cleaning plants increased from 3 million tons in 1929 to 31 million in 1949. The ratio of refuse to raw coal increased from 9 percent in 1929 to 17 percent in 1949. Increased mechanical loading during this period was the major reason for additional refuse. Mechanical loading plus mechanical cleaning often will give a lower over-all production cost. Other important factors that tended to increase the percentage of refuse it was necessary to remove from the raw coal were (1) Decreased demand for large lumps, (2) increased demand for stoker sizes, (3) increased practice of "full-seam mining,"3/ (4) depletion of some of the better coals, and (5) general demand for cleaner coal.

The number of mechanical cleaning plants increased from 236 in 1928 to 571 in 1949, and the average output per plant increased from 122,000 to 269,000 tons of cleaned coal per year during the same period.

Bituminous coal produced at mines with cleaning plants increased from 66 million tons (12 percent of the total production) in 1929 to 206 million tons (47 percent of the total production) in 1949.

Consumer-operated plants include plants owned by steel companies that receive coal from various mines (but usually from affiliated companies), clean it, and then consume it directly at the plant. The tonnage of bituminous coal cleaned by consumer-operated plants increased from 3 million tons in 1927 to 8 million tons in 1949, but the ratio of coal cleaned at consumer-operated plants to the total cleaned decreased from 11 percent to 5 percent during the same interval.

The ratio of tons cleaned at mines to total production at mines with cleaning plants increased from 49 percent in 1929 to 71 percent in 1949.

Figure 1 shows the relation of the output of bituminous coal mechanically cleaned to total production by methods of mining and loading. The three lines "mechanically cleaned," "mechanically loaded," and "strip mined" follow approximately the same pattern. The gap between "mechanically loaded" and "mechanically cleaned" increased during the war years 1940-45, owing to limited construction of new cleaning plants.

3/ Anderson, R. L., Mining Congress Journal, May 1947, pp. 41-44.

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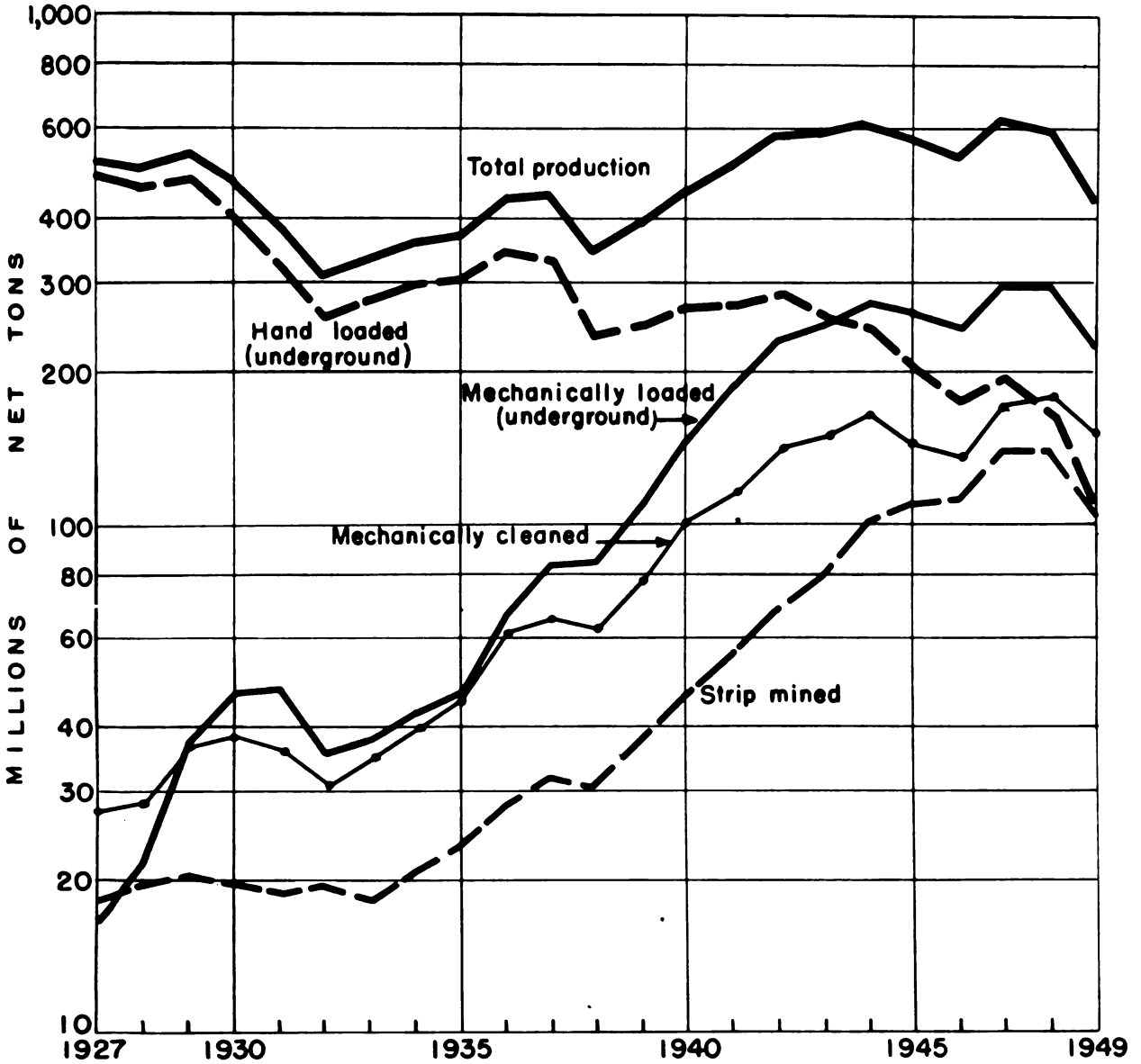

Figure 1. - Bituminous coal production by methods of mining and loading and total output mechanically cleaned in the United States, 1927-49.

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TABLE 1.--Growth of mechanical cleaning at bituminous-coal mines in the United States, 1927-49

Year	Total production thousand tons 1/	Production at mines with cleaning plants thousand tons	Number of cleaning plants 2/	Raw coal thousand tons 2/	Cleaned coal				Refuse		Percent of total production mechanically cleaned
					At mines		At consumer operated plants thousand tons	Total thousand tons	Thousand tons	Percent of raw coal	
					Thousand tons	Percent 3/					
1927 ----	517,763	(4)	(4)	(4)	24,770	(4)	2,922	27,692	(4)	(4)	5.3
1928 ----	500,745	(4)	236	(4)	24,975	(4)	3,808	28,783	(4)	(4)	5.7
1929 ----	534,989	65,987	280	40,241	32,272	48.9	4,527	36,799	3,442	8.6	6.9
1930 ----	467,526	66,510	297	42,645	35,690	53.7	3,110	38,800	3,845	9.0	8.3
1931 ----	382,089	69,839	312	39,529	33,578	48.1	2,594	36,172	3,357	8.5	9.5
1932 ----	309,710	56,872	309	32,903	27,357	48.1	2,921	30,278	2,625	8.0	9.8
1933 ----	333,630	64,796	290	37,682	30,566	47.2	3,992	34,558	3,124	8.3	10.4
1934 ----	359,368	76,309	293	43,556	35,854	47.0	3,973	39,827	3,729	8.6	11.1
1935 ----	372,373	87,166	320	49,473	39,511	45.3	5,850	45,361	4,112	8.3	12.2
1936 ----	439,088	115,402	342	67,162	53,386	46.3	7,709	61,095	6,067	9.0	13.9
1937 ----	445,531	(4)	(4)	(4)	(4)	(4)	(4)	65,000	(4)	(4)	14.6
1938 ----	348,545	108,238	374	71,207	57,999	53.6	5,456	63,455	7,752	10.9	18.2
1939 ----	394,855	133,314	366	88,895	72,628	54.5	6,801	79,429	9,466	10.6	20.1
1940 ----	460,771	161,736	387	115,692	93,520	57.8	8,750	102,270	13,422	11.6	22.2
1941 ----	514,149	185,468	417	133,379	108,288	58.4	9,252	117,540	15,839	11.9	22.9
1942 ----	582,693	218,074	438	162,598	131,397	60.3	10,790	142,187	20,411	12.6	24.4
1943 ----	590,177	222,898	432	167,310	135,609	60.8	9,967	145,576	21,734	13.0	24.7
1944 ----	619,576	232,936	439	182,071	148,455	63.7	10,272	158,727	23,344	12.8	25.6
1945 ----	577,617	214,258	439	172,899	138,835	64.8	9,051	147,886	25,013	14.5	25.6
1946 ----	533,922	200,274	445	163,633	131,732	65.8	6,938	138,670	24,963	15.3	26.0
1947 ----	630,624	244,512	461	206,620	164,311	67.2	10,125	174,436	32,184	15.6	27.7
1948 ----	599,518	251,712	502	215,217	170,478	67.7	10,402	180,880	34,337	16.0	30.2
1949 ----	437,868	206,322	571	184,691	145,603	70.6	8,049	153,652	31,039	16.8	35.1

1/ Includes all coal produced (excluding refuse) in the United States and Alaska except Pennsylvania anthracite.
2/ Includes central washeries operated by consumer steel companies.
3/ Ratio of cleaned coal at mines to total production from mines with cleaning plants.
4/ Data not available.

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Figure 2 shows the percentage of bituminous coal produced by surface stripping, mechanical loading, and hand loading, 1927-49. The percentage of the total production that was loaded by hand decreased from 93 in 1927 to 25 in 1949, mechanical loading increased from 3 to 51 and strip mining increased from 4 to 24 percent during the same period. The percentage of the total bituminous coal that was mechanically cleaned, 1927-49, is shown on figure 3. Thus, mechanical cleaning increased simultaneously with mechanical mining.

Mechanical Cleaning by Types of Equipment

Table 2 shows the quantity of bituminous coal cleaned, by types of equipment, and percentage cleaned by each type, 1927-49. Many cleaning plants use more than one type of equipment. In 1949, 67 plants were using both wet and pneumatic methods, but separate data were reported for each. Separate tonnage figures by type of cleaning were not reported for the following cleaning plants in 1949: 15 using jigs and tables, 11 using jigs and launders, 8 using jigs and classifiers, and 17 using other combinations of wet methods.

Jigs. - The oldest and most common type of coal-cleaning equipment is the jig. The first bituminous-coal washery in the United States was a piston jig built in 1869 near Pittsburgh, Pa., to clean slack.4/ There are three general types of jigs - basket, piston, and Baum. The basket jig was the first to be developed, it consists of a sieve that moves upward and downward in a tank of water. The piston jig was the next stage in the development of coal cleaning. It consists of a fixed sieve, the water being forced through the coal by use of a piston. The Baum-type jig is the most recent development and the most popular jig in use today. It is a fixed-screen jig with a sealed chamber in which the pulsations are given to the water by compressed air. The first Baum-type jigs installed in the United States were Link-Belt Simon-Carves washeries built in 1928 in Indiana and Pennsylvania. Other Baum jigs now commonly used in the United States are the McNally-Norton washer introduced in 1931 and the Jeffrey Baum jig introduced in 1934. During 1949 more than half of the total bituminous coal mechanically cleaned in the United States was cleaned by jigs, and about three-fourths of the tonnage cleaned by jigs was cleaned by Baum jigs.

Concentrating tables. - Wet process coal-washing tables as we know them today have been in use in the United States approximately 40 years. A Wilfley concentrating table was installed in New Mexico for coal washing in 1911, and Deister-Overstrom and Plat-O tables were first installed in the same State in 1916-17.4/ A few table installations worthy of note before adoption of our present-day differential-motion table are as follows: Six Campbell bumping tables were operated in western Kentucky in 1893; as late as 1923, 72 such tables were in operation in Pennsylvania.5/ Bumping tables were the forerunners of our present-day concentrating tables. Coal-washing tables are mainly advantageous in treating sizes from 1/4-inch down to 48 or 65 mesh; however, several recent installations include sizes up to 1-1/4-inch. During 1949 about 6 million tons or 4 percent of the total bituminous coal cleaned in the United States was cleaned by coal-washing tables.

4/ Coal Age, February 1940, p. 74.
5/ Ganrud, B. W., Coal Preparation, A.I.M.E. 1943, p. 425.

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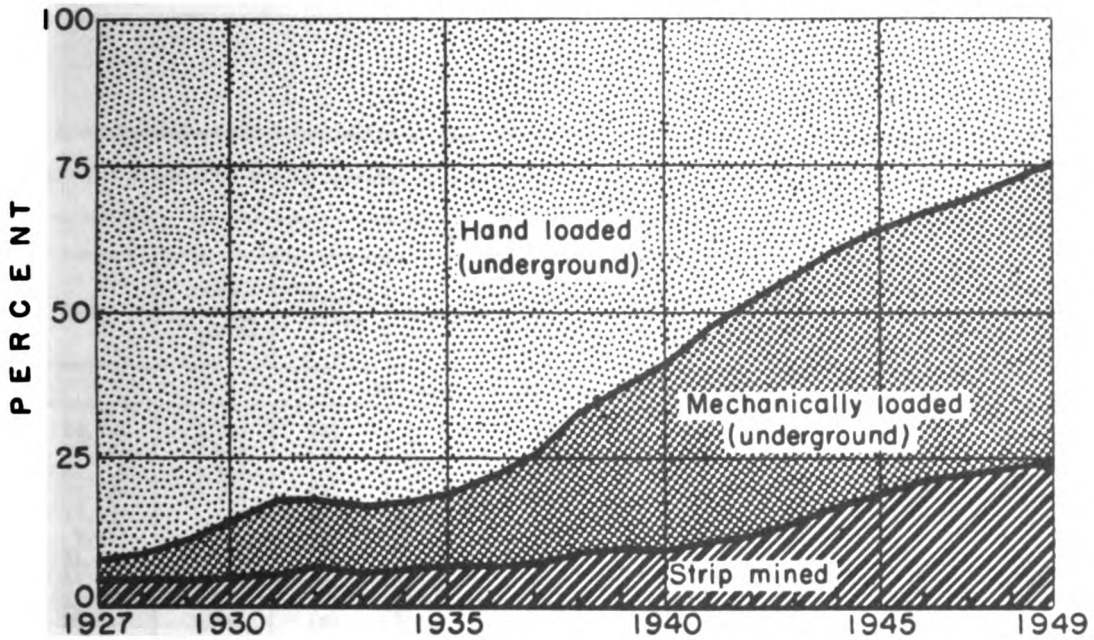

Figure 2. - Percentage of total bituminous coal produced by methods of mining and loading in the United States, 1927-49.

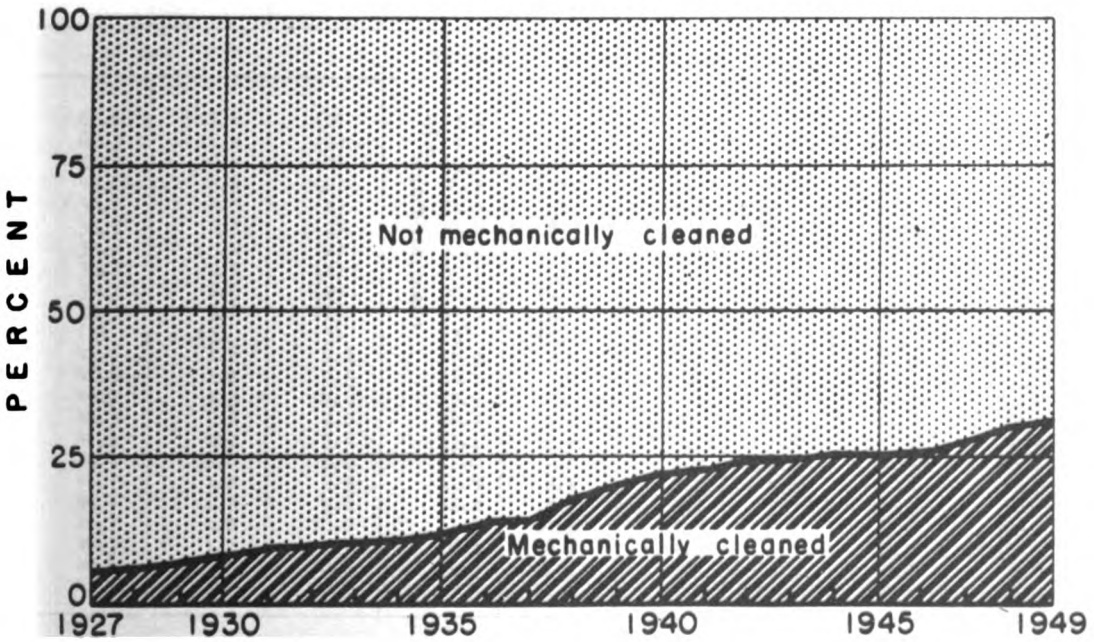

Figure 3. - Percentage of total bituminous coal production mechanically cleaned in the United States, 1927-49.

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TABLE 2.--Bituminous coal mechanically cleaned in the United States, by types of equipment, 1927-49

(Includes coal cleaned at plants operated by consumers at central washeries in Colorado and Pennsylvania)

Year	Wet methods								Pneumatic methods	Total
	Jigs	Concentrating tables	Classifiers	Launders	Dense media	Jigs and tables	Other combinations 1/	Total		
	Thousands of net tons of clean coal									
1927 --	18,741	3,200	(2)	2/ 1,000	(2)	300	800	24,041	3,651	27,692
1928 --	17,927	3,412	(2)	2/ 2,446	(2)	1,056	156	24,997	3,786	28,783
1929 --	18,915	3,532	(2)	2/ 7,103	(2)	1,214	191	30,955	5,844	36,799
1930 --	17,724	2,272	(2)	2/ 9,818	(2)	1,029	62	30,905	7,895	38,800
1931 --	13,957	1,551	(2)	2/ 11,213	(2)	926	11	27,658	8,514	36,172
1932 --	9,963	821	(2)	2/ 12,140	(2)	806	9	23,739	6,539	30,278
1933 --	11,895	1,119	(2)	2/ 13,272	(2)	693	5	26,984	7,574	34,558
1934 --	14,012	1,116	(2)	2/ 15,168	(2)	1,227	6	31,529	8,298	39,827
1935 --	15,735	1,118	(2)	2/ 18,454	(2)	1,549	---	36,856	8,505	45,361
1936 --	23,417	1,843	(2)	2/ 22,631	(2)	2,613	---	50,504	10,591	61,095
1937 --	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	65,000
1938 --	27,615	984	4,521	10,681	4,450	2,791	2,145	53,187	10,268	63,455
1939 --	37,056	1,402	5,917	12,809	4,683	3,256	2,611	67,734	11,695	79,429
1940 --	47,064	2,330	7,762	16,269	6,692	2,765	4,408	87,290	14,980	102,270
1941 --	53,287	2,510	8,177	16,954	9,344	4,364	5,742	100,378	17,162	117,540
1942 --	66,876	3,138	10,529	18,658	12,495	4,366	5,938	122,000	20,187	142,187
1943 --	66,092	2,929	11,854	17,424	13,388	4,322	8,366	124,375	21,201	145,576
1944 --	74,175	2,753	14,780	19,686	13,869	4,649	8,751	138,663	20,064	158,727
1945 --	68,609	2,594	14,203	18,980	12,875	4,754	8,455	130,470	17,416	147,886
1946 --	64,702	1,447	13,883	16,021	14,173	3,776	8,057	122,059	16,611	138,670
1947 --	85,931	2,980	14,648	17,902	17,702	4,303	12,617	156,083	18,353	174,436
1948 --	87,506	4,360	18,304	16,788	20,638	5,252	11,816	164,664	16,216	180,880
1949 --	72,423	4,040	14,865	11,238	17,821	3,288	17,033	140,708	12,944	153,652
	Percent cleaned by each type									
1927 --	67.6	11.6	(2)	2/ 3.6	(2)	1.1	2.9	86.8	13.2	100.0
1928 --	62.3	11.8	(2)	2/ 8.5	(2)	3.7	.5	86.8	13.2	100.0
1929 --	51.4	9.6	(2)	2/ 19.3	(2)	3.3	.5	84.1	15.9	100.0
1930 --	45.6	5.9	(2)	2/ 25.3	(2)	2.7	.2	79.7	20.3	100.0
1931 --	38.6	4.3	(2)	2/ 31.0	(2)	2.6	(4)	76.5	23.5	100.0
1932 --	32.8	2.7	(2)	2/ 40.2	(2)	2.7	(4)	78.4	21.6	100.0
1933 --	34.4	3.2	(2)	2/ 38.5	(2)	2.0	(4)	78.1	21.9	100.0
1934 --	35.2	2.8	(2)	2/ 38.1	(2)	3.1	(4)	79.2	20.8	100.0
1935 --	34.7	2.5	(2)	2/ 40.7	(2)	3.4	---	81.3	18.7	100.0
1936 --	38.3	3.0	(2)	2/ 37.1	(2)	4.3	---	82.7	17.3	100.0
1937 --	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	---
1938 --	43.5	1.6	7.1	16.8	7.0	4.4	3.4	83.8	16.2	100.0
1939 --	46.6	1.8	7.5	16.1	5.9	4.1	3.3	85.3	14.7	100.0
1940 --	46.0	2.3	7.6	15.9	6.5	2.7	4.3	85.3	14.7	100.0
1941 --	45.3	2.2	7.0	14.4	7.9	3.7	4.9	85.4	14.6	100.0
1942 --	47.0	2.2	7.4	13.1	8.8	3.1	4.2	85.8	14.2	100.0
1943 --	45.4	2.0	8.1	12.0	9.2	3.0	5.7	85.4	14.6	100.0
1944 --	46.7	1.8	9.3	12.4	8.8	2.9	5.5	87.4	12.6	100.0
1945 --	46.4	1.8	9.6	12.8	8.7	3.2	5.7	88.2	11.8	100.0
1946 --	46.7	1.0	10.0	11.6	10.2	2.7	5.8	88.0	12.0	100.0
1947 --	49.3	1.7	8.4	10.3	10.1	2.5	7.2	89.5	10.5	100.0
1948 --	48.4	2.4	10.1	9.3	11.4	2.9	6.5	91.0	9.0	100.0
1949 --	47.1	2.6	9.7	7.3	11.6	2.2	11.1	91.6	8.4	100.0

1/ Includes all other wet methods.
2/ Launders include classifiers and dense medium for 1927-36, inclusive.
3/ Data not available.
4/ Less than 0.05 percent.

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Classifiers. - The general theory of coal-cleaning with the classifiers or upward-current washer (also jigs) is that a particle sinks in an upward current of water if the speed of the current is less than the terminal velocity of fall of the particle in still water, and rises if the speed of the current exceeds the terminal velocity of fall.6/ In commercial practice particles to be separated are a mass of particles in a relatively small volume of water, therefore hindered settling conditions prevail. A Robinson washer installed in Alabama in 1892 was the first classifier used in the United States, and the Menzies hydroseparator was first used in the bituminous coal fields in 1926.7/ The first Hydrotator used to clean bituminous coal was installed in 1939 at a central Pennsylvania mine, and the first Menzies cone separator installed to clean bituminous coal went into operation in 1936 to clean 2-1/2- to 1/2-inch coal in West Virginia.8/ Most classifier-type equipment is restricted to cleaning coal from which the fine slack has been removed. In 1949 approximately 17 million tons or 11 percent of the total bituminous coal cleaned in the United States was cleaned by classifiers.

Launders. - Although the most primitive methods used for concentrating ores were launders or trough washers they were little used for cleaning coal until the Reholaveur was developed. The first Rheolaveur used in the United States for cleaning bituminous coal was installed in Colorado in 1925, the Link-Belt trough washer was first used in conjunction with Baum jigs at mines in West Virginia in 1936, and the first Koppers-Battelle launder was installed in West Virginia in 1937.9/ The Morrow-Prins washer is a combination launder or trough washer and jig. Approximately 14 million tons or 9 percent of the total bituminous coal cleaned in the United States in 1949 was cleaned in launders.

Dense medium. - The dense-medium process of coal cleaning uses the familiar float-and-sink procedure on a commercial scale. Just as pieces of wood float on water and sand sinks, so coal floats and refuse sinks when placed in a medium intermediate in specific gravity between the coal and refuse. The Chance process, using a mixture of sand and water, was first installed for cleaning bituminous coal in Pennsylvania in 1925. The first Belknap-chloride washer was installed in West Virginia in 1935. A large plant, using magnetite as the medium, was installed at Gary, West Virginia in 1948. There are several other dense-medium processes in use in the United States, but the Belknap and Chance are the most widely used at present. Generally, the minus-1/8-inch slack is removed before the coal is cleaned by dense-medium processes. About 24 million tons or 15 percent of the total bituminous coal cleaned in the United States in 1949 was cleaned by dense-medium processes.

The Fraser air-sand process of coal cleaning was first installed in Pennsylvania in 1930. It employs a dense medium which is formed by bubbling air through a mass of dry sand. The air fluidizes the sand, the coal floats on the aerated sand mass, and the refuse sinks. Although the air-sand is generally grouped with dense-medium processes, it is included with pneumatic processes in this study.

6/ Chapman, W. R. and Mott, R. A., The Cleaning of Coal, 1928, p. 181.
7/ Coal Age, February 1940, pp. 74-75.
8/ Griffin, John, Coal Preparation, A.I.M.E. 1943, pp. 319 and 331.
9/ Coal Age, February 1940, p. 75.

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Pneumatic methods. - Bituminous coal cleaning by pneumatic methods includes air tables, air flow or air jigs, and air sand. The first commercial pneumatic table used for coal cleaning was installed in New Mexico in 1919 and later became known as the American oscillating table.

Four other successful pneumatic coal-cleaning machines have been developed and introduced to the American coal-mining industry:

1. Peale Davis: "Pneumo-Gravity" machine, 1924
2. Arms "Concentrator," oscillating table, 1924
3. Heyl and Patterson oscillating table, 1927
4. "Stump Air-Flow," pulsating air jig, 1932[10/]

American oscillating tables and the Stump Air-Flow are the predominant pneumatic coal cleaners in the United States today. Pneumatic methods are generally used for cleaning small sizes of bituminous coal and often are used in conjunction with some type of wet cleaning.

Froth flotation of coal in the United States began about 1918 with experiments at the Mellon Institute. Although it is applicable to the cleaning of fine sizes (minus 48 mesh), it may be employed on sizes as coarse as 1/8-inch. To date the bituminous coal cleaned by froth flotation in the United States has been negligible.

There are several miscellaneous processes of cleaning coal, other than the methods previously described, but they are either in the experimental stage or not commonly used for cleaning bituminous coal.

Methods of Mining at Mines Served by Cleaning Plants

Rapid progress has been made in mechanical loading of bituminous coal since 1927. The ratio of output of bituminous coal mechanically loaded at both strip and underground mines to the total production increased from 7 percent in 1927 to 75 percent in 1949. During the same period, the ratio of output of mechanically cleaned coal to total production increased from 5 to 35 percent. (See figs. 2 and 3)

Table 3 gives the record of total bituminous coal production and production from mines with cleaning plants, by methods of mining, from 1933 to 1949, inclusive. With the rapid growth of strip mining and underground mechanical loading, the necessity for mechanical cleaning became more urgent. Mechanical cleaning paced strip mining from 1933 through 1938 and underground mechanical loading through 1939. The rapid growth of strip mining, especially the numerous hillside operations, and restrictions on new cleaning plants during the World War II reversed the trend. The ratio of production from strip mines with cleaning plants to total strip production decreased from 50 percent in 1938 to 29 percent in 1946. Cleaning at underground mines with mechanical loading remained fairly constant throughout the war years (1941-45); about 50 percent of the production mechanically loaded was produced at mines with cleaning plants. In 1949 the ratio of production from mines with cleaning plants to the total production at strip mines and underground mines with mechanical loading

10/ Carris, R. E., Coal Preparation, A.I.M.E. 1943, p. 494.

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was about 37 and 64 percent, respectively. There has been little change at "underground mines with hand loading" in the percentage of output from mines with cleaning plants to the total production, although the production hand loaded decreased from 278 million tons in 1933 to 109 million in 1949.

Figure 4 shows the percentage of bituminous coal produced at mines with cleaning plants, by methods of mining and loading. Production at strip mines with mechanical cleaning increased from 5 percent of the total in 1933 to 19 percent in 1949, and production at underground mines with mechanical loading and served by cleaning plants increased from 13 to 69 percent of the total during the same period. Production at underground mines with hand loading and served by cleaning plants decreased from 82 percent of the production at mines with cleaning plants in 1933 to 12 percent in 1949.

Figure 5 shows the ratio of production from bituminous-coal mines with cleaning plants to total production, by methods of mining and loading for 1933-49, inclusive.

Bituminous Coal Cleaning by States

Table 4 gives the production mechanically cleared, by States, and table 5 gives the percentage of State output that was cleaned mechanically by years, 1927-49, inclusive. Certain States are grouped to conceal confidential reports on individual operations. Alabama was the only State that cleaned more than half the total production in the State in 1927, while in 1949, six States, Alabama, Illinois, Indiana, Kansas, Missouri, and Washington, mechanically cleaned more than half of their total output. Although there was a large increase in mechanical cleaning from 1927 to 1949, five States (Alabama, Colorado, Michigan, Tennessee, and Washington) cleaned less coal in 1949 than in 1927.

Table 6 gives 1949 data on bituminous coal cleaning by States. The State of Washington had the highest ratio of coal cleaned to total production (89 percent), Missouri was second, and Alabama, Indiana, and Illinois followed in order named. (See column 3 in table 6.) In terms of total tonnage mechanically cleaned, including central washeries operated by consumer-steel companies, West Virginia led with 37 million tons, followed by Pennsylvania with 32 million tons, Illinois, Kentucky, and Indiana followed in order named. The ratio of refuse to raw coal ranged from an average of 5 percent in Utah to 27 percent in New Mexico. A few individual plants handled a ratio of almost 50 percent in 1949.

Sales of New Equipment

Reports from 18 manufacturers of bituminous-coal cleaning equipment show that the 1949 sales in the United States, in terms of capacity, were 13,300 net tons of clean coal per hour compared with 17,700 tons sold in 1948. The ratio of 1949 sales of new bituminous coal cleaning plants to additions or replacements of present plants, in terms of capacity, was 35 percent new plants and 65 percent additions or replacements. The annual capacity of bituminous-coal cleaning equipment sold in 1949, based on the average number of days the mines were active in 1949 (157) and 7 hours per day, was 14,600,000 net tons of cleaned coal.

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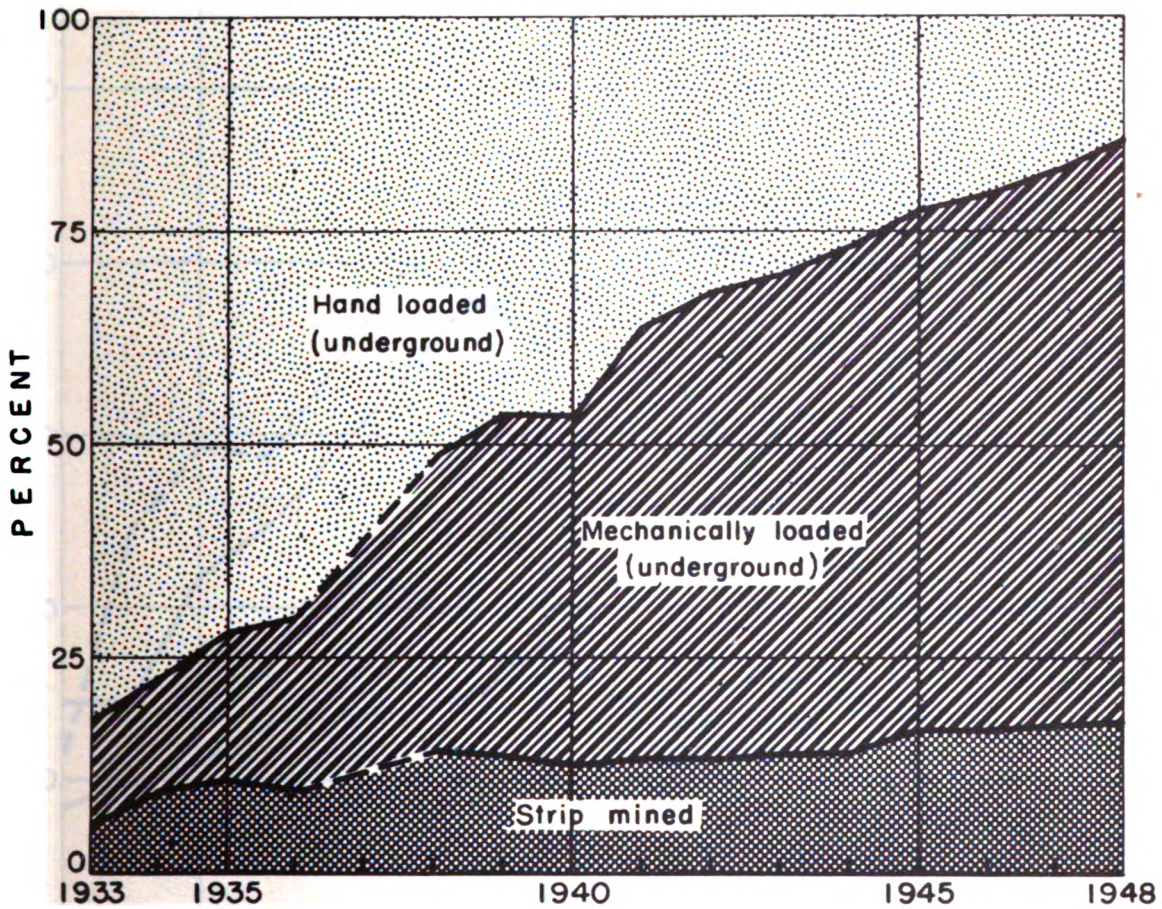

Figure 4. - Percentage of total output from bituminous coal mines served by cleaning plants, by methods of mining and loading, in the United States, 1933-48.

(Excludes consumer-operated washeries)

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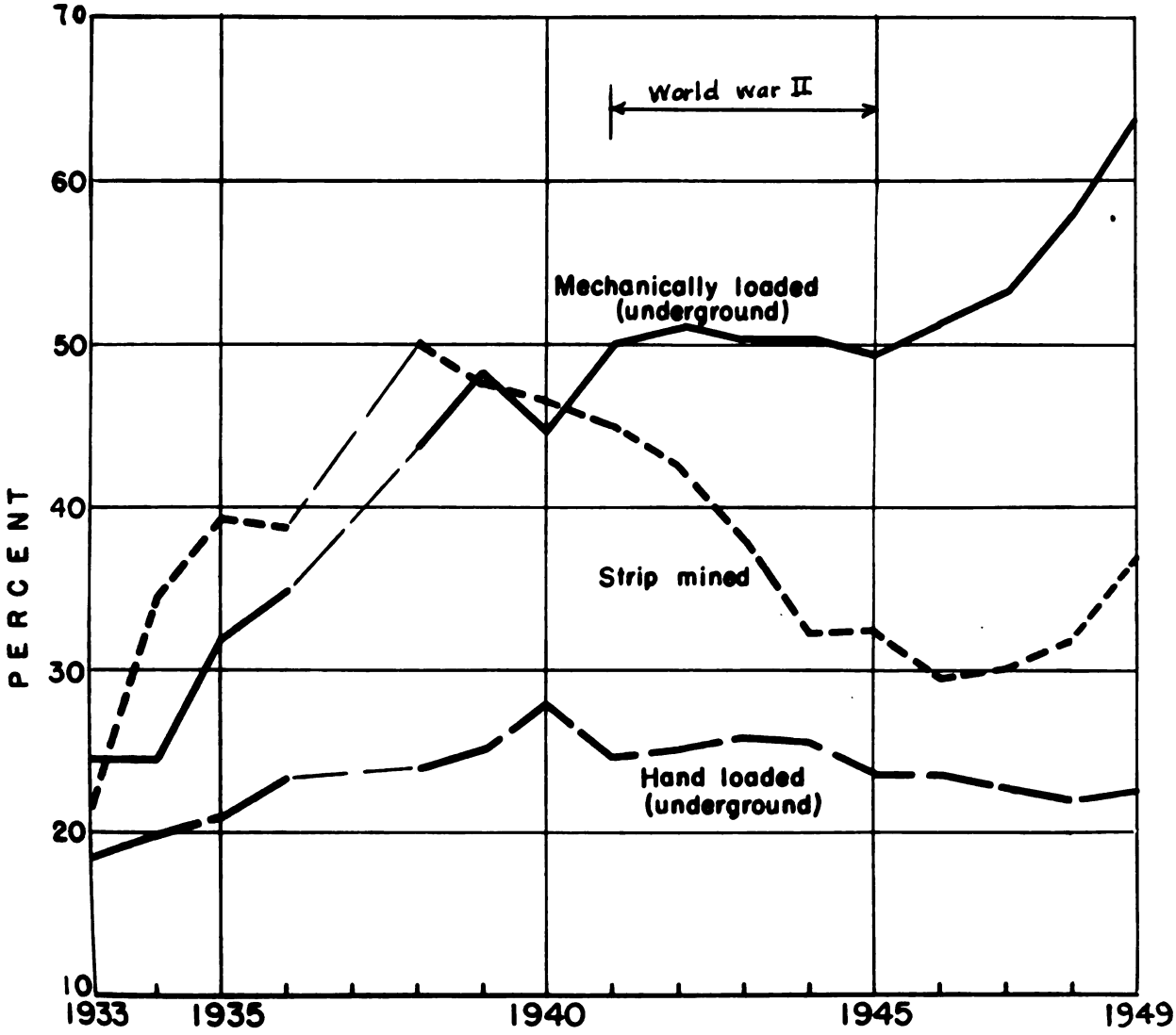

Figure 5. - Percentage of bituminous coal output produced at mine served by cleaning plants by methods of mining and loading, in the United States, 1933-49.

(Excludes consumer-operated washeries)

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TABLE 3.--Method of mining at bituminous-coal mines in the United States served by cleaning plants, 1933-49 1/

Year	Strip mines			Underground mines						Total all mines		
				Mechanical loading			Hand-loading					
	Total production thousand tons	Production from mines with cleaning plants		Production mechanically loaded thousand tons	Production from mines with cleaning plants		Production hand-loaded, thousand tons	Production from mines with cleaning plants		Grand total production thousand tons	Production from mines with cleaning plants	
		Thousand tons	Percent of total		Thousand tons	Percent of total		Thousand tons	Percent of total		Thousand tons	Percent of total
1933 --	15,270	3,940	21.6	37,821	9,253	24.5	277,539	51,603	18.6	333,630	64,796	19.4
1934 --	20,790	7,128	34.3	41,433	10,129	24.4	297,145	59,052	19.9	359,368	76,309	21.2
1935 --	23,647	9,314	39.4	47,177	15,066	31.9	301,549	62,786	20.8	372,373	87,166	23.4
1936 --	28,126	10,953	38.9	66,977	23,462	35.0	343,985	80,987	23.5	439,088	115,402	26.3
1937 --	31,751	(2)	(2)	83,500	(2)	(2)	330,280	(2)	(2)	445,531	(2)	(2)
1938 --	30,407	15,214	50.0	85,093	37,195	43.7	233,045	55,829	24.0	348,545	108,238	31.1
1939 --	37,722	17,960	47.6	110,712	53,496	48.3	246,421	61,858	25.1	394,855	133,314	33.8
1940 --	43,167	20,030	46.4	147,870	66,148	44.7	269,734	75,558	28.0	460,771	161,736	35.1
1941 --	55,071	24,773	45.0	186,667	93,374	50.0	272,411	67,321	24.7	514,149	185,468	36.1
1942 --	67,203	28,597	42.6	232,903	118,917	51.1	282,587	70,560	25.0	582,693	218,074	37.4
1943 --	79,685	30,326	38.1	249,805	125,314	50.2	260,687	67,258	25.8	590,177	222,898	37.8
1944 --	100,898	32,444	32.2	274,189	137,927	50.3	244,489	62,565	25.6	619,576	232,936	37.6
1945 --	109,987	35,910	32.6	262,512	129,733	49.4	205,118	48,615	23.7	577,617	214,258	37.1
1946 --	112,964	33,222	29.4	245,341	125,521	51.2	175,617	41,531	23.6	533,922	200,274	37.5
1947 --	139,395	42,017	30.1	298,157	158,507	53.2	193,072	43,988	22.8	630,624	244,512	38.8
1948 --	139,506	44,305	31.8	295,806	171,346	57.9	164,206	36,061	22.0	599,518	251,712	42.0
1949 --	106,045	38,972	36.8	222,376	142,797	64.2	109,447	24,553	22.4	437,868	206,322	47.1

1/ Does not include any estimate for mines that may ship to consumer-operated plants. Comparable data for earlier years are not available.
2/ Data not available.

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TABLE 4.--Bituminous coal mechanically cleaned by wet and pneumatic methods, in the United States, by States, 1927-49, in net tons of clean coal

(Includes central washeries operated by consumers in Colorado and Pennsylvania)

Year	Alabama	Alaska	Arkansas	Colorado	Illinois	Indiana	Kansas	Kentucky	Maryland	Michigan	Missouri
1927	13,153,643	---	9,250	1,362,998	560,642	250,282	---	309,262	---	155,190	---
1928	13,064,095	---	6,893	1,276,764	442,054	245,522	---	541,975	---	111,469	---
1929	13,585,632	---	9,839	1,270,985	526,551	498,415	---	457,655	---	157,369	---
1930	11,760,020	---	(1)	888,005	2/ 1,152,817	(3)	---	290,780	(1)	(4)	(1)
1931	9,303,386	---	(1)	542,265	2/ 1,546,459	(3)	---	341,954	(1)	(4)	(1)
1932	5,842,039	---	(1)	284,749	2/ 1,640,221	(3)	(1)	331,416	(1)	(4)	(1)
1933	6,729,913	---	(1)	361,870	2/ 1,756,812	(3)	(5)	233,238	(1)	(4)	6/ 454,911
1934	7,150,888	---	(1)	417,295	2/ 2,323,242	(3)	(5)	308,735	(1)	(4)	6/ 813,488
1935	6,841,269	---	(1)	492,874	3,154,128	1,283,555	(5)	351,568	(1)	(4)	6/ 1,169,351
1936	9,922,514	---	(1)	713,678	5,613,522	2,198,067	(5)	514,647	(1)	(4)	6/ 1,771,870
1937	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
1938	9,072,987	---	(1)	458,876	10,160,640	2,564,010	1,053,966	1,270,274	(1)	(1)	1,289,480
1939	9,938,993	52,754	(1)	793,271	14,108,576	3,589,173	1,138,039	2,116,523	(1)	(1)	1,054,664
1940	12,923,860	64,567	(1)	1,067,856	18,840,805	5,103,522	1,620,407	2,004,360	---	(1)	1,236,799
1941	12,835,169	69,665	(1)	1,216,128	22,126,723	7,205,041	2,283,689	3,005,717	---	(1)	1,517,861
1942	15,697,911	73,417	(1)	1,157,313	27,209,284	9,052,500	2,565,936	4,622,553	---	(1)	1,487,060
1943	13,326,372	100,780	35,638	1,180,248	30,321,306	9,612,008	1,845,362	6,896,774	---	25,290	2,334,203
1944	14,453,892	188,558	41,877	1,131,259	32,965,139	11,667,478	1,672,834	8,374,636	---	17,880	3,525,474
1945	13,831,185	158,800	71,951	1,135,679	30,710,862	11,135,525	1,588,125	8,043,420	---	11,949	2,960,031
1946	11,608,231	164,623	98,177	901,069	28,164,779	10,669,696	1,273,764	8,270,196	---	7,554	2,991,932
1947	13,923,152	171,799	250,060	1,373,708	33,363,568	13,865,723	1,349,393	12,195,014	318,498	---	3,071,263
1948	13,463,049	147,360	134,569	1,530,318	34,619,845	13,530,612	1,191,344	11,560,556	216,637	---	3,310,227
1949	9,360,954	190,384	55,491	1,223,987	27,428,245	10,548,456	1,101,022	12,894,543	71,914	---	3,004,757

See footnotes at end of table.

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TABLE 4.—Bituminous coal mechanically cleaned by wet and pneumatic methods, in the United States, by States, 1927-49, in net tons of clean coal - continued

(Includes central washeries operated by consumers in Colorado and Pennsylvania)

Year	Montana	New Mexico	Ohio	Oklahoma	Pennsylvania	Tennessee	Utah	Virginia	Washington	West Virginia	Other States	Total
1927	142,802	---	7,278	5,646	5,625,092	344,562	---	1,289,496	820,481	3,655,423	---	27,692,047
1928	101,586	---	---	---	6,905,546	326,903	---	269,271	892,498	4,598,463	---	28,783,039
1929	73,293	---	204,543	---	11,100,193	308,449	---	(8)	967,098	9/ 7,639,098	---	36,799,120
1930	(1)	---	10/ 719,646	---	13,496,934	297,768	---	(8)	819,662	9/ 9,227,968	146,019	38,799,619
1931	---	---	10/ 816,906	(1)	12,657,958	249,453	---	(8)	603,497	9/ 9,715,433	395,062	36,172,373
1932	---	---	10/ 854,123	(1)	10,799,082	247,650	---	(8)	485,610	9/ 9,323,094	470,385	30,278,369
1933	---	(1)	10/ 1,123,115	(1)	12,722,812	308,778	---	(8)	519,417	9/ 10,267,905	79,440	34,558,211
1934	(1)	(1)	10/ 1,260,654	(1)	15,652,530	341,530	---	(8)	400,336	9/ 11,002,766	155,357	39,826,559
1935	(1)	(1)	10/ 1,151,546	---	17,844,642	341,117	---	389,548	614,771	11,613,813	112,839	45,361,021
1936	(1)	(1)	10/ 1,331,545	---	21,584,403	257,987	---	473,992	1,203,783	15,360,671	148,297	61,094,976
1937	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	65,000,000
1938	(1)	(1)	2,121,344	---	17,047,977	258,089	(1)	814,478	1,197,054	15,888,325	11/ 257,088	63,454,588
1939	(1)	(1)	2,800,280	---	21,462,135	320,206	(1)	1,272,296	1,366,754	18,812,410	11/ 603,352	79,429,426
1940	(1)	(1)	3,533,632	---	27,616,594	314,541	(1)	2,315,560	1,362,856	23,384,440	12/ 879,954	102,269,753
1941	(1)	(1)	4,626,146	---	29,948,020	337,159	(1)	2,733,166	1,632,427	26,724,333	12/ 1,278,278	117,539,522
1942	(1)	90,738	6,022,900	---	35,712,262	455,413	1,413,048	3,062,674	1,726,599	31,607,271	12/ 200,467	142,187,346
1943	146,503	53,703	6,611,721	108,942	35,429,650	438,168	839,111	3,292,751	1,347,160	31,630,159	---	145,575,849
1944	211,692	95,856	6,362,939	244,010	37,349,752	350,229	2,064,798	3,670,435	1,254,605	33,083,786	---	158,727,129
1945	302,978	303,470	6,292,400	239,169	32,880,671	114,695	1,682,138	3,623,548	1,114,360	31,671,908	13/13,072	147,885,936
1946	171,882	395,347	6,467,864	90,000	29,807,425	125,276	1,636,201	3,401,629	816,465	31,592,766	13/14,961	138,669,837
1947	170,522	477,873	9,366,478	385,442	36,728,026	188,572	1,679,577	3,375,524	954,734	41,227,011	---	174,435,937
1948	182,721	411,325	10,340,972	706,311	35,602,133	266,900	2,134,386	4,098,567	1,055,749	46,376,742	---	180,880,323
1949	182,411	339,672	9,011,617	738,718	31,984,239	193,884	2,086,754	3,714,188	802,071	38,718,596	---	153,651,903

1/ Included with "Other States."
2/ Includes Indiana.
3/ Included with Illinois.
4/ Included with Ohio.
5/ Included with Missouri.
6/ Includes Kansas.
7/ Data not available.
8/ Included with West Virginia.
9/ Includes Virginia.
10/ Includes Michigan.
11/ Includes also Texas.
12/ Includes also Georgia.
13/ Oregon.

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TABLE 5.--Percentage of State output of bituminous coal mechanically cleaned by wet and pneumatic methods, 1927-49

(Includes central washeries operated by consumers in Colorado and Pennsylvania)

Year	Alabama	Alaska	Arkansas	Colorado	Illinois	Indiana	Kansas	Kentucky	Maryland	Michigan	Missouri
1927 ---	66.5	---	.6	14.0	1.2	1.4	---	.4	---	20.5	---
1928 ---	74.1	---	.4	13.0	.6	1.5	---	.9	---	18.1	---
1929 ---	75.7	---	.6	12.8	.9	2.7	---	.8	---	19.6	---
1930 ---	75.5	---	(1)	10.8	2/ 1.6	(3)	---	.6	(1)	(4)	(1)
1931 ---	77.5	---	(1)	8.2	2/ 2.6	(3)	---	.9	(1)	(4)	(1)
1932 ---	74.4	---	(1)	5.1	2/ 3.5	(3)	(1)	.9	(1)	(4)	(1)
1933 ---	76.8	---	(1)	6.9	2/ 3.4	(3)	(5)	.6	(1)	(4)	6/ 8.1
1934 ---	78.2	---	(1)	8.0	2/ 4.1	(3)	(5)	.8	(1)	(4)	6/ 13.9
1935 ---	80.4	---	(1)	8.3	7.1	8.2	(5)	.9	(1)	(4)	6/ 18.5
1936 ---	81.1	---	(1)	10.5	11.0	12.3	(5)	1.1	(1)	(4)	6/ 25.5
1937 ---	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
1938 ---	82.0	---	(1)	8.1	24.2	17.4	39.7	3.3	(1)	(1)	37.5
1939 ---	82.5	35.5	(1)	13.4	30.2	21.2	42.5	5.0	(1)	(1)	32.2
1940 ---	84.3	37.1	(1)	16.2	37.2	27.0	45.3	4.1	---	(1)	39.9
1941 ---	83.0	29.2	(1)	17.5	40.4	32.0	57.0	5.6	---	(1)	48.3
1942 ---	81.3	28.1	(1)	14.3	41.8	35.8	60.7	7.4	---	(1)	42.2
1943 ---	77.7	34.8	2.1	14.2	41.7	38.3	53.7	10.9	---	15.0	54.2
1944 ---	77.1	54.1	2.1	13.9	42.9	41.7	49.7	11.7	---	12.8	73.8
1945 ---	75.8	53.4	3.9	15.0	42.1	44.2	49.2	11.6	---	9.5	74.3
1946 ---	71.7	44.9	6.0	15.2	44.4	49.2	51.1	12.4	---	9.4	80.2
1947 ---	73.1	47.6	13.4	21.6	49.2	54.5	49.2	14.5	15.5	---	72.5
1948 ---	71.6	36.1	8.1	27.2	53.0	56.7	46.9	14.1	13.0	---	82.3
1949 ---	72.4	43.9	5.8	26.4	58.1	63.7	54.2	20.6	10.8	---	82.4

See footnotes at end of table.

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TABLE 5.--Percentage of State output of bituminous coal mechanically cleaned by wet and pneumatic methods, 1927-49 - continued

(Includes central washeries operated by consumers in Colorado and Pennsylvania)

Year	Montana	New Mexico	Ohio	Oklahoma	Pennsylvania	Tennessee	Utah	Virginia	Washington	West Virginia	Other States	Total
1927	4.5	---	.1	.1	4.2	6.0	---	10.0	31.1	2.5	---	5.3
1928	3.1	---	---	---	5.3	5.8	---	2.3	35.4	3.5	---	5.7
1929	2.2	---	.9	---	7.7	5.7	---	(8)	38.4	9/ 5.5	---	6.9
1930	(1)	---	10/ 3.1	---	10.8	5.8	---	(8)	35.6	9/ 7.0	1.4	8.3
1931	---	---	10/ 3.9	(1)	13.0	5.3	---	(8)	32.7	9/ 8.7	4.5	9.5
1932	---	---	10/ 5.9	(1)	14.4	7.0	---	(8)	30.5	9/ 10.0	4.8	9.8
1933	---	(1)	10/ 5.6	(1)	16.0	8.2	---	(8)	37.3	9/ 10.0	1.6	10.4
1934	(1)	(1)	10/ 5.9	(1)	17.4	8.3	---	(8)	28.9	9/ 10.2	2.1	11.1
1935	(1)	(1)	10/ 5.3	---	19.5	8.3	---	4.0	39.4	11.7	1.6	12.2
1936	(1)	(1)	10/ 5.4	---	19.6	5.1	---	4.1	66.4	13.0	1.9	13.9
1937	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	14.6
1938	(1)	(1)	11.4	---	21.9	5.8	(1)	6.6	76.4	17.0	11/ 2.4	18.2
1939	(1)	(1)	13.8	---	23.2	6.2	(1)	9.4	80.9	17.4	11/ 5.4	20.1
1940	(1)	(1)	15.5	---	23.7	5.2	(1)	15.1	82.6	18.5	12/ 9.3	22.2
1941	(1)	(1)	15.8	---	23.0	4.8	(1)	14.8	88.7	19.1	12/ 12.2	22.9
1942	(1)	5.4	18.4	---	24.8	5.6	25.6	15.2	88.4	20.3	12/ 3.3	24.4
1943	3.1	2.9	20.5	3.8	25.1	6.1	12.6	16.2	88.2	19.9		24.7
1944	4.4	5.5	18.8	7.6	25.6	4.8	29.0	18.8	82.3	20.1		25.6
1945	6.8	20.5	19.2	8.2	24.7	1.8	25.2	21.0	82.1	20.8	13/ 79.2	25.6
1946	4.6	30.9	20.0	3.4	23.8	2.2	27.3	21.9	82.4	21.9	13/ 87.2	26.0
1947	5.4	33.1	24.9	11.3	25.0	3.0	22.6	16.7	85.4	23.4	---	27.7
1948	6.3	30.2	26.7	20.4	26.5	4.1	31.3	22.8	86.5	27.5	---	30.2
1949	6.6	33.8	29.1	24.4	35.9	4.6	33.9	25.5	89.2	31.6	---	35.1

1/ Included with "Other States."
2/ Includes Indiana.
3/ Included with Illinois.
4/ Included with Ohio.
5/ Included with Missouri.
6/ Includes Kansas.
7/ Data not available.
8/ Included with West Virginia.
9/ Includes Virginia.
10/ Includes Michiga.
11/ Includes also Texas.
12/ Includes also Georgia.
13/ Oregon.

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TABLE 6.--Result of operations at bituminous-coal-cleaning plants in the United States, by States, in net tons, in 1949

State	Number of plants in operation	Percent of total production mechanically cleaned	Total raw coal moved to cleaning plants	Coal obtained in cleaning process	Refuse resulting in cleaning process	Ratio of refuse to raw coal (percent) 1/	Total production from mines served by cleaning plants
Alabama	56	72.4	12,806,624	9,360,954	3,445,670	26.9	9,802,007
Alaska	2	43.9	249,085	190,384	58,701	23.6	190,720
Arkansas	3	5.8	64,991	55,491	9,500	14.6	209,411
Colorado	7	2.7	134,062	123,041	11,021	8.2	563,110
Illinois	62	58.1	33,130,226	27,428,245	5,701,981	17.2	37,723,135
Indiana	26	63.7	12,204,622	10,548,456	1,656,166	13.6	12,759,347
Kansas	5	54.2	1,381,829	1,101,022	280,807	20.3	1,220,381
Kentucky	52	20.6	15,631,029	12,894,543	2,736,486	17.5	17,730,655
Maryland	2	10.8	86,107	71,914	14,193	16.5	216,129
Missouri	9	82.4	3,830,856	3,004,757	826,099	21.6	3,058,323
Montana	2	6.6	195,511	182,411	13,100	6.7	220,341
New Mexico	2	33.8	467,963	339,672	128,291	27.4	666,939
Ohio	20	29.1	11,323,570	9,011,617	2,311,953	20.4	11,792,199
Oklahoma	5	24.4	870,051	738,718	131,333	15.1	1,122,263
Pennsylvania 2/	73	28.1	30,560,607	25,036,181	5,524,426	18.1	32,333,632
Tennessee	4	4.6	223,186	193,884	29,302	13.1	605,215
Utah	5	33.9	2,195,919	2,086,754	109,165	5.0	2,491,551
Virginia	21	25.5	4,119,971	3,714,188	405,783	9.8	6,825,104
Washington	19	89.2	1,001,507	802,071	199,436	19.9	829,786
West Virginia 3/	190	31.6	45,295,837	38,295,596	6,577,241	14.5	65,961,917
Total at mines only 4/	565	33.3	175,773,553	145,602,899	30,170,654	17.2	206,322,165
Consumer plants 5/	6	---	8,917,449	8,049,004	868,445	9.7	---
Grand total 1949 6/	571	35.1	184,691,002	153,651,903	31,039,099	16.8	---

1/ In Alabama (for example) for every 100 tons of raw coal cleaned in 1949, an average of 26.9 tons of refuse was discarded and 73.1 tons of clean marketable coal was obtained.
2/ Includes some coal that was mined in Pennsylvania and cleaned in Ohio.
3/ Includes some coal that was mined in West Virginia and cleaned in Ohio and Pennsylvania.
4/ Includes all mechanical cleaning other than washeries operated by consumer steel companies.
5/ Includes central washeries in Colorado and Pennsylvania operated by consumer steel companies.
6/ Represents 67 plants using both wet and pneumatic methods of cleaning and 504 plants using only 1 cleaning method.

Interior - Bureau of Mines, Pittsburgh, Pa.

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